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User Engagement with Mobile Technologies: A Multi-Dimensional Conceptualization of Technology Use

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Completed Research Paper

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Abstract

Our study conceptualizes user engagement – a form of technology use targeting the emerging ubiquitous mobile technology generation such as mobile health (mHealth) and social network applications. User engagement manifests in three dimensions, including behavioral, cognitive, and emotional engagement. We validated the measures (in both objective and subjective forms) for the three-dimension user engagement in two different mobile technology contexts, i.e., an e-nursing mobile application and a question-and-answer social network application. We further delineated the relationships among the three dimensions: 1) prior behavioral engagement contributed to both emotional and cognitive engagement, 2) emotional engagement lead to post behavioral engagement, and 3) emotional engagement, compared with prior behavioral engagement and cognitive engagement, exerted a stronger influence predicting post behavioral engagement. Our study enriches both technology use and engagement literature.

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Introduction

A new generation of mobile technologies came into use and become ubiquitous over the past decade, including mobile applications for education, nursing, sports, etc., and social networks for e-commerce, knowledge sharing, online communities, etc. (Turban et al. 2018). Nevertheless, sustained use of such ubiquitous technologies is still a big challenge today. For example, although there are 2.8 million mobile applications (apps) available in Google Play and 2.2 million apps in Apple's App Store (Statista 2018), 23% of users abandon an app after installation on their mobile devices for the first time (O'Connell 2016). Likewise, even on the most popular social network sites like Snapchat and Twitter, the churn rate is as high as 25% (Hwong 2017). Managers from the unicorns are keen to know how to engage users with a constructive and involved state so that the new generation of mobile technologies prosper and the embedded business and social value be realized.

IS scholars have long been investigating the concept of technology use at the individual level, and our study aims to address three knowledge gaps with the prior literature on technology use. First, previous studies conceptualized usage behaviors of early technology generations, and limited knowledge is available on usage behaviors targeting the emerging mobile technology context. One stream of studies focused on users' duration and frequency of use (Davis et al. 1989; Venkatesh et al. 2003) and use continuance (Bhattacherjee 2001, 2004) of the previous technology generation like World Wide Web and earlier versions of Office tools and e-commerce. Another stream of studies examined effective use (Burton-Jones and Grange 2013; Burton-Jones and Straub 2006), adaptive use (Barki et al. 2007; Beaudry and Pinsonneault 2005; Jasperson et al. 2005; Sun 2012), or even innovative use (Ahuja and Thatcher 2005; Li et al. 2013) of organizational complex information systems like enterprise resource planning (ERP) systems and business intelligence (BI) systems. Some recent studies tapped into the mobile technology context, and interpreted individual technology use in relatively simple forms such as continued intention to use or variety and frequency of use (Hoehle and Venkatesh 2015; Venkatesh et al. 2012).

Second, the ubiquitous mobile technology context calls for a multi-dimensional conceptualization of technology use. Prior technology use studies usually focused on one particular aspect of technology use, e.g., cognition (Agarwal and Karahanna 2000; Polites and Karahanna 2012) and emotion (Beaudry and Pinsonneault 2010; Guinea and Markus 2009; Zhang 2013), and treated such cognitive and emotional aspects of technology use as predictors of behavioral outcomes in terms of frequency, duration, or intention of use. Compared with earlier technology generations such as World Wide Web, email, and Office tools, the new mobile technology generation is much more interactive and flexible, and expects users' active participation and long-term commitment during usage processes. Besides, different from organizational complex information systems that entail much functionalities to support comprehensive tasks and allow for innovation and exploration, the new mobile technology generation is established on lightweight models and very easy and simple to use. Thus, usage behaviors of the new mobile technology generation need a broader conceptual boundary encompassing not only behavioral, but also cognitive and emotional aspects in use.

Third, the user engagement construct desires further development in the IS field, though the concept of engagement has been appropriated across various domains, including education (Furner and Skinner 2003), marketing (Brodie et al. 2011), healthcare (Graffigna et al. 2013), and business organizations (Khan 1990; Rich et al. 2010). Engagement represents a person's active, constructive, and flexible state when fulfilling some role in a certain environment (Graffigna et al.'s 2013; Khan 1990). An engaged state manifests in three aspects – behavioral, cognitive, and emotional (Dessart et al. 2016; Furner and Skinner 2003; Rich et al. 2010) and should be distinguished from a passive state of conditional reflex established

through stimulation-and-response reinforcement. A handful of IS studies have taken initiatives to introduce user engagement into the IS field. Webster and Ahuja (2006) conceptualized user engagement as a relatively passive state in users; Ray et al. (2014) conceived user engagement as active participation in online communities and with a solo dimension in both definition and measurement.

Targeting the three knowledge gaps, our study aims to develop a three-dimension technology use construct that captures users' engaged state in using the new generation of mobile technologies – user engagement or engaged use with mobile technologies. First, users display sustainable usage *behaviors* in terms of frequency of use, duration of use, and continuance intention when interacting with a mobile technology. Second, users allocate focused and immersed attention and devote much *cognitive* resources in using the mobile technology. Third, users are *emotionally* affectionate toward the mobile technology and even psychologically attach to the technology throughout usage processes. We expect our study not only advance the theoretical development on technology use in the IS field, but also provide practical insights for practitioners unleashing business and social value embedded in the new generation of ubiquitous mobile technologies together with their generated big data. In the following, we review relevant literature on the engagement concept from several other disciplines and conceptualize user engagement with mobile technologies. We further clarify the differences between user engagement and other relevant constructs in the IS field. We develop and validate the measures for user engagement in two empirical studies with two different mobile technology contexts. We also delineate the relationships among the three dimensions of user engagement. Finally, we discuss the theoretical and practical implications of our findings as well as the next stage of our research.

Conceptualization of User Engagement with Mobile Technologies

We review the engagement concept in several disciplines, including organizational behavior, consumer psychology, education psychology, healthcare, and its preliminary application in the IS field (Table 1) (MacKenzie et al. 2011). In *organizational behavior*, Kahn (1990) was among the first to contextualize the engagement concept into the organizational setting. Kahn defines work engagement through the role theory and as employees' harnessing full selves in physical behavior, cognition, and emotion during work performances (Khan 1990). A high level of work engagement means that employees diligently express their preferred selves in work-related tasks. Khan (1990) employed the methods of observation and in-depth interviews when investigating work engagement. Rich et al. (2010) followed Kahn's (1990) conceptualization, and developed and validated work engagement measures along the three dimensions of physical behavior, cognition, and emotion. Another stream of literature conceived work engagement as a persistent and constructive motivational state in organizations including three dimensions of vigor, dedication, and absorption and developed the Utrecht Work Enthusiasm Scale (UWES) (e.g., Salanova et al. 2005; Schaufeli et al. 2002; Sonnentag 2003) to measure work engagement. Nevertheless, scholars challenged UWES for mixing the engagement construct with its antecedents together (Rich et al. 2010).

In *consumer psychology*, consumer engagement refers to the constructive psychological state experienced by consumers when undergoing interaction or co-creation with a particular object (Brodie et al. 2011). Such particular objects range from a brand (Dessart et al. 2016) or brand-related content (Schivinski et al. 2016), an online brand community (Wirtz et al. 2013), to a service (Jaakkola and Alexander 2014). At the measurement level, some studies assessed consumer engagement either as a behavior (Schivinski et al. 2016) or a motivational state in general (Baldus et al. 2015), while others incorporated multiple dimensions including consumers' behavior, cognition, and affection (Dessart et al. 2016; Hollebeek et al. 2014).

In *education psychology*, academic engagement involves behavioral and emotional dimensions, encompassing a series of interactive, flexible, goal-oriented learning activities in both physical and social environments (Furner and Skinner 2003). Students' academic engagement is in contrast with the traditional stimulus-response learning mode. Scholars assessed academic engagement through two alternative methods. Some measured emotional and behavioral engagement in classrooms from both teachers' and students' evaluation (Furner and Skinner 2003). Some others employed the National Survey of Student Engagement (NSSE) to measure the time and energy that students devote in learning processes (Chen et al. 2010).

In the *healthcare* domain, Graffigna et al. (2013) drew insights from positive psychology and conceptualized patient engagement as a subjective and cooperative process during treatment or care management. Graffigna et al.'s (2013) conceptualization of patient engagement is essentially in consistency with work engagement (Kahn 1990; Rich et al. 2010) but yet to be operationalized.

User engagement firstly came to *the IS field* in the technology context of the Internet. Webster and Ahuja (2006) regarded user engagement as close to the concepts of involvement and flow but with a relatively passive state in users. They adapted the set of measures from flow (Csikszentmihalyi 1975) by excluding the dimension of user control. User engagement predicted intention to use and task performance. Ray et al. (2014) defined and measured user engagement as a single dimension construct, which stands for active participation in online communities. While the handful of IS studies did take initiatives appropriating the important concept of engagement into the IS field, both conceptualization and operationalization of user engagement can be further improved.

Table 1. Engagement in Different Contexts

Construct (Discipline)	Definition
Academic engagement (Education Psychology)	"Active, goal-directed, flexible, constructive, persistent, focused interactions with the social and physical environments" (Furner and Skinner 2003, p. 149).
Consumer engagement (Consumer Psychology)	"A psychological state that occurs by virtue of interactive, cocreative customer experiences with a focal agent/object (e.g., a brand) in focal service relationships" (Brodie et al. 2011, p.260).
Patient engagement (Healthcare)	"A subjective experiential process caused by conative, cognitive, and emotional enactment of people in care and cure management"(Graffigna et al. 2013, p. 2034)
User engagement (IS Field)	The Internet: "Similar to flow, a state representing the extent of pleasure and involvement in an activity…Engagement is a subset of flow and represents a more passive state." (Webster and Ahuja 2006, pp. 664-665). Online community: "The enthusiasm of members for contributing to their community because they feel it is an action that is effective, meaningful, and challenging" (Ray et al. 2014, p.531)
Work engagement (Organizational Behavior)	"The harnessing of organization members' selves to their work roles by which they employ and express themselves physically, cognitively, and emotionally during role performances" (Khan 1990, p. 694). "A multidimensional motivational concept reflecting the simultaneous investment of an individual's physical, cognitive, and emotional energy in active, full work performance" (Rich et al. 2010, p. 619).

Note: All constructs in the table are list in alphabetic order.

We define ***user engagement with mobile technologies*** as a form of effective use in which users are active and constructive in using and interacting with mobile technologies. Taking insights from the above reviewed literature, an engaged person in general would be physically involved in activities relating to role performances, cognitively vigilant and attentive, and emotionally connected to some role-related agent (Brodie et al. 2011; Furner and Skinner 2003; Kahn 1990, 1992). Similarly, in the context of mobile technology use, user engagement manifests in three aspects, behavioral, cognitive, and emotional engagement. Specifically, engaged users would be actively using mobile technologies in terms of duration, frequency, and long-term commitment; engaged users would be concentrate and cognitively absorbed when interacting with mobile technologies; engaged users would also be emotionally attached to and feeling affective toward mobile technologies. This conceptualization of ***engaged use*** targets the ubiquitous mobile technology context – established on lightweight models, very simple and easy to use, and involving much interactions and commitment from users throughout usage processes.

We further distinguish user engagement with several relevant constructs in the IS field (Table 2). The first categories of constructs are involvement, flow, and cognitive absorption. We group the three constructs together because each of them has been considered as identical to engagement in the IS literature but needs to be differentiated from user engagement that is conceptualized in our study. User involvement refers to a psychological state that users attach significance and relevance to a particular technology (Barki and Hartwick 1989). Flow is the psychological state in which people are so deeply involved that

"nothing else seems to matter" (Csikszentmihalyi 1990, p. 4), and are comprised of four dimensions in the technology use settings, including control, attention focus, curiosity, and intrinsic interest (Koufaris 2002; Trevino and Webster 1992; Webster et al. 1993). Some scholars consider engagement as "a subset of flow" without the control dimension (Webster and Ahuja 2006, p. 665; Webster and Hackley 1997) (also see Table 1), while others develop cognitive absorption by adding flow with other dimensions, e.g., temporal dissociation (Agarwal and Karahanna 2000), or computer playfulness and ease of use (Agarwal et al. 1997). In essence, involvement describes a psychological state of technology use in general; flow and cognitive absorption entails both cognitive and emotional elements. Involvement, flow, and cognitive absorption predict usage behaviors. On the contrary, user engagement includes three aspects of behavior, cognition, and emotions, and is in itself a form of technology use with a broader conceptual boundary.

The second category of constructs mainly concern users' spontaneous or affective reactions toward technology use, including playfulness, intrinsic motivation, and arousal (Russell and Barrett 1999). Computer playfulness extends the playfulness concept (Barnett 1991; Lieberman 1977) into the technology use settings, referring to users' cognitive spontaneity when interacting with computers (Webster and Martocchio 1992). Computer playfulness is both a trait and a state in using computers (Webster 1989; Webster et al. 1993), and playful users are usually intrinsically motivated (Wesbter and Martocchio 1992). Rich intrinsic motivation is a motivational state in which users experience enjoyment and satisfaction in using technologies and varies across different technology contexts (Li et al. 2013). Arousal stands for the subjective and affective experience in performing psychological and physical activities (Deng and Poole 2010). Such spontaneity or affection in using technologies as playfulness, intrinsic motivation, and arousal, reasonably promotes user engagement as a constructive form of technology use, but is not included in its definition. Note that the emotional aspect of user engagement refers to users' affective attachment to a particular technology when either using or not using it (Barki and Hartwick 1989; Brodie et al. 2011), and should not be confused with the spontaneous reactions taking place only in use.

Table 2. Relevant Constructs in Prior IS Literature

Construct	Definition
Addiction	"Online auction addiction is defined as a ***maladaptive psychological dependency*** on the use of online auctions to such a degree that typical ***behavioral*** addiction symptoms occur" (Turel et al. 2011, p.1046).
Arousal	"Arousal refers to the nonspecific component of ***emotional response*** that reflects the intensity rather than the evaluative quality of affect … is defined as the subjective experience of energy mobilization for psychological and motor activity" (Deng and Poole 2010, p. 714).
Cognitive absorption	Cognitive absorption is "a ***state of deep involvement*** with software that is exhibited through five dimensions: temporal dissociation, or the inability to register the passage of time while engaged in interaction; focused immersion, or the experience of total engagement where other attentional demands are, in essence, ignored; heightened enjoyment, capturing the pleasurable aspects of the interaction; control, representing the user's perception of being in charge of the interaction; and curiosity, tapping into the extant the experience arouses an individual's sensory and cognitive curiosity" (Agarwal and Karahanna 2000, p. 673).
Flow	"Flow is a multidimensional construct characterized by the four dimensions discussed above: control, attention focus, curiosity, and intrinsic interest" (Webster et al. 1993, p. 414); "flow has ***both emotional and cognitive components***…namely, intrinsic enjoyment, perceived control, and concentration/ attention focus" (Koufaris 2002, pp. 207-208).
Intrinsic motivation	Intrinsic motivation toward accomplishment refers to "the ***pleasure and satisfaction*** that users experience when solving problems or overcoming difficulties in using IS"; intrinsic motivation to know means "the ***pleasure and satisfaction*** that users experience when learning new things or trying to understand something new in using IS"; intrinsic motivation to experience stimulation is "the ***pleasure and satisfaction*** that users experience when interacting with IS" (Li et al. 2013, pp. 664-665).
Involvement	User involvement refers to "a ***subjective psychological state*** of the individual and defined as the importance and personal relevance that users attach either to a particular system or to IS in general, depending on the users' focus" (Barki and Hartwick 1989, pp. 59-60).
Participation	User participation refers to "the ***behaviors and activities*** that the target users or their

Table 2. Relevant Constructs in Prior IS Literature	
Construct	Definition
	representatives perform in the systems development process" (Barki and Hartwick 1989, p. 59).
Playfulness	Computer playfulness captures a concrete psychometric disposition that is manifested through users' ***cognitive*** spontaneity when interacting with computers; "the ***trait*** of microcomputer playfulness represents a relatively enduring tendency to interact playfully with microcomputers, while the ***state*** of microcomputer playfulness represents a temporary state of playfulness with microcomputers brought on by such influences as characteristics of the software, social influences, and so on" (Webster and Martocchio 1992, p. 204).

Note: All constructs in the table are list in alphabetic order.

Finally, both addiction and participation denote physical activities and behaviors in the technology use settings. Addiction is a pathological form of technology use resulting from certain maladaptive psychological state (Turel et al. 2011); participation describes technology use activities in a neutralized tone; user engagement is a positive form of technology use behavior and will not bring negative consequences to users (Charlton and Danforth 2007). Moreover, the conceptual boundary of user engagement is broader than physical behaviors; it is a multi-dimensional construct further incorporating cognitive and emotional aspects of technology use.

Two Empirical Studies

We next develop the measures and validate them in two different mobile technology contexts (Appendix A). We operationalized behavioral engagement in two formative items of use duration and frequency (Claussen et al. 2013; Venkatesh et al. 2003). We also assessed behavioral engagement intention (2 items) in terms of use duration and frequency, and treated it as a proxy for behavioral engagement in the near future (Bhattacherjee 2001; Claussen et al. 2013; Thomson et al. 2005). We consider cognitive engagement as covering two aspects of attention (3 items) and absorption (2 items) in using mobile technologies, and derived corresponding items from Rothbard (2001). We referred to emotional attachment to brands which includes three dimensions of affection, connection, and passion (Thomson et al. 2005), and developed the measures of affection (3 items) and connection (3 items) constituting emotional engagement. Scholars agreed that attaching selves closely to technologies is important manifestation of engagement (Barki and Hartwick 1989; Brodie et al. 2011). We identified that the measures of affection and connection most appropriately capture emotional engagement, and the measures for passion seem to overlap with behavioral engagement as well as the affection dimension and were therefore dropped. All measures employ the 7-point Likert scale, ranging from "strongly disagree" to "strongly agree". We also included age, education, gender, and prior use experience of the investigated technology as control variables (Venkatesh et al. 2003).

We used the back-translation method to convert our questionnaire from English to Chinese (Brislin 1970). We invited 20 MBA students to participate in a pilot study and the psychometric properties of the measures turned out to be acceptable. We also conducted informal interviews with the 20 participants and obtained their feedback on the design of our survey and the translated measures. We carefully refined the wording of our measures and instrument design based on the feedback. Then, we formally administered our questionnaire in two different mobile technology contexts.

Sites and Sample

In Study 1, 115 users of an e-nursing mobile application (app) participated in the survey. All participants were randomly selected patients who recently underwent certain surgery and needed assistance and guidance from the e-nursing app during their recovery processes. We collected self-reported data on cognitive and emotional engagement from the 115 patients and obtained clickstream data for 87 of them from the e-nursing app provider. The clickstream data for each participant elapsed from the first time they downloaded the e-nursing app to six weeks after they filled in the questionnaires. ANOVA test results suggest that there were no significant differences in demographic information, cognitive engagement, and emotional engagement between the group of 87 samples with clickstream data and the group of 28 without clickstream data. We conducted Study 2 on the mobile version of a popular question-and-answer

social network site. We randomly administered our survey to 300 users and obtained 206 effective responses. ANOVA test results again suggest there were no significant non-response bias in age, gender, education, and income level between the responded and no-response groups. In the survey, we measured behavioral engagement, behavioral engagement intention, cognitive engagement, and emotional engagement. Table 3 presents the demographic information on participants in the two studies.

Table 3. Demographic Information

		Study 1 (N=115)		Study 2 (N=206)	
		Frequency	Percentage	Frequency	Percentage
Age	15-20	7	6.1%	57	27.7%
	21-30	48	41.7%	116	56.3%
	31-40	40	34.8%	24	11.7%
	41 and above	20	17.4%	9	4.4%
Education	High school or below	45	39.1%	6	2.9%
	Associate degree	37	32.2%	16	7.8%
	Bachelor or above	33	28.7%	184	89.3%
Gender	Male	46	40.0%	123	59.7%
	Female	69	60.0%	83	40.3%
Use Experience	Less than 0.5 wk/yr	20	17.4%	23	11.2%
	0.5-1 wk/yr	55	47.8%	30	14.6%
	1-2 wks/yrs	23	20.0%	69	33.5%
	More than 2 wks/ yrs	17	14.8%	84	40.8%
Total		**115**	**100.0%**	**206**	**100.0%**

Note: We asked participants their use experience based on weeks in Study 1 and years in Study 2.

Measurement Validation

Table 4 shows the descriptive statistics of our measures. We validated user engagement for its construct validity and reliability. First, construct validity contains convergent validity and discriminant validity (Bagozzi et al. 1991). We evaluated convergent validity in terms of factor loadings and average variance extracted (AVE) (Table 5).[1] In both studies, all of the factor loadings were statistically significant and higher than 0.7 (Falk and Miller 1992), and all AVE values were above the criterion of 0.50 (Fornell and Larcker 1981). These evidences collectively suggested good convergent validity of our measures. We then used two methods to check discriminant validity. In both studies, the square root of AVE value of each construct was higher than its correlations with other constructs (Fornell and Larcker 1981), and each construct's item loadings were greater than its cross-loadings on other constructs (Chin 1998; Gefen and Straub 2005).[4] Again, results indicated acceptable discriminant validity of our measures. Second, we assessed construct reliability in terms of Cronbach's alpha and composite reliability. In both studies, the values of Cronbach's alpha and composite reliabilities of all constructs were greater than the suggested threshold of 0.707 (Chin 1998; Straub 1989). Therefore, we conclude that our measures demonstrated good psychometric properties in both Studies 1 and 2.

[1] Due to space limit, we do not present the table of item loadings and cross-loadings.

Table 4. Descriptive Statistics

		Study 1 (N=115)		Study 2 (N=206)	
		Mean	Standard Deviation	Mean	Standard Deviation
Behavioral Engagement (BE)	Use Frequency	0.536	0.279	1.850	0.971
	Use Duration	2.025	0.462	1.951	0.974
Behavioral Engagement Intention (BE-Int)	Use Frequency			5.121	1.369
	Use Duration			5.893	1.118
Cognitive Engagement(CE)		4.736	1.288	4.170	1.572
Emotional Engagement(EE)		5.042	1.180	4.490	1.548

Note: We did log transformation for use frequency and duration of the clickstream data (i.e., behavioral engagement) in Study 1.

Table 5. Psychometric Properties

	Study 1 (N=115)			Study 2 (N=206)			
	BE	CE	EE	BE	BE-Int	CE	EE
Behavioral Engagement Intention (BE-Int)	--	--		0.170	--		
Cognitive Engagement(CE)	0.144	0.847	--	0.340	0.438	0.871	
Emotional Engagement(EE)	0.041	0.663	0.882	0.390	0.531	0.722	0.847
Cronbach's Alpha		0.901	0.943			0.920	0.920
Composite Reliability		0.927	0.954			0.940	0.938
Average Variance Extracted (AVE)		0.717	0.778			0.758	0.717

Note: The diagonal elements are square roots of AVEs; the off-diagonal elements are correlations among factors.

We also performed measurement invariance analysis for the constructs of cognitive and emotional engagement and obtained configural and metric invariance of the measures across the two empirical studies (Vandenberg 2002; Vandenberg and Lance 2000). First, we constructed a baseline model to examine if factor structures are the same across the two studies, i.e., configural invariance test, and received good model fit indices (χ^2/ df=2.964, CFI = 0.949 , NNFI = 0.927, RMSEA = 0.078, SRMR = 0.072) (Hair et al. 1998; Hu and Bentler 1998). Second, we constrained all factor loadings to be equal across the two studies to perform metric invariance test (Doll et al. 1998; Steenkamp and Baumgartner 1998) and obtained good indices again, (χ^2/ df=2.835, CFI = 0.947 , NNFI = 0.932, RMSEA = 0.076, SRMR = 0.074). There was no significant change in model fit indices between the baseline model and the later one ($\Delta\chi^2$= 15.747, Δdf = 9, ΔCFI = 0.002). In summary, the measures of cognitive and emotional engagement were invariant across the two empirical studies. Besides, we used three techniques to assess the common method bias for the two data sets, including Harman's single-factor test (Podsakodd and Organ 1986), Podsakoff's common-method-variance-factor test (Podsakoff et al. 2003), and the marker variable test (Lindell and Whitney 2001). Due to space limit, we do not present details in this paper. Results of all tests indicated that common method bias was not a major threat for both studies.

Relationships among the Three Dimensions of User Engagement

We conceive the three dimensions of user engagement as formative at the second level and the two items of behavioral engagement also as formative at the first level (Gefen and Straub 2005; Petter et al. 2007) (also see Appendix A). We further examined the structural relationships among the three dimensions of user engagement in SmartPLS 3.0 (Ringle et al. 2015) and present the results in Table 6. In Study 1, we separated users' clickstream data into prior and post behavioral engagement according to the time each participants filled their questionnaires. We found that prior behavioral engagement positively influenced cognitive engagement ($\beta_{\text{Prior-BE}\rightarrow\text{CE}}$ = 0.273, p-value = 0.007) and emotional engagement ($\beta_{\text{Prior-BE}\rightarrow\text{EE}}$ = 0.199, p-value = 0.034); emotional engagement positively influenced post behavioral engagement ($\beta_{\text{EE}\rightarrow\text{Post-BE}}$ = 0.292, p-value = 0.038). In Study 2, we treated the data on usage behaviors as prior behavioral engagement and behavioral engagement intention as a proxy for behavioral engagement in the

near future. Again, prior behavioral engagement positively influenced cognitive engagement ($\beta_{Prior\text{-}BE \rightarrow CE}$ =0.325, p-value =0.000) and emotional engagement ($\beta_{Prior\text{-}BE \rightarrow EE}$ = 0.385, p-value = 0.000); emotional engagement positively influenced behavioral engagement intention ($\beta_{EE \rightarrow BE\text{-}Int}$ = 0.455, p-value = 0.000). Interestingly, neither prior behavioral engagement nor cognitive engagement significantly influenced post behavioral engagement ($\beta_{Prior\text{-}BE \rightarrow Post\text{-}BE}$ = 0.144, p-value = 0.794; $\beta_{CE \rightarrow Post\text{-}BE}$ = -0.271, p-value = 0.065) in Study 1 or behavioral engagement intention ($\beta_{Prior\text{-}BE \rightarrow BE\text{-}Int}$ = -0.073, p-value = 0.334; $\beta_{CE \rightarrow BE\text{-}Int}$ = 0.130, p-value = 0.114) in Study 2.

Additionally, we statistically compared the influences of prior behavioral, emotional, and cognitive engagement on post behavioral engagement (post-behavioral engagement in Study 1; behavioral engagement intention in Study 2), by following the procedures by Cohen et al. (2003). As shown in Table 7, we confirmed that emotional engagement exerted a stronger influence on post behavioral engagement than either prior behavioral engagement or cognitive engagement across the two studies.

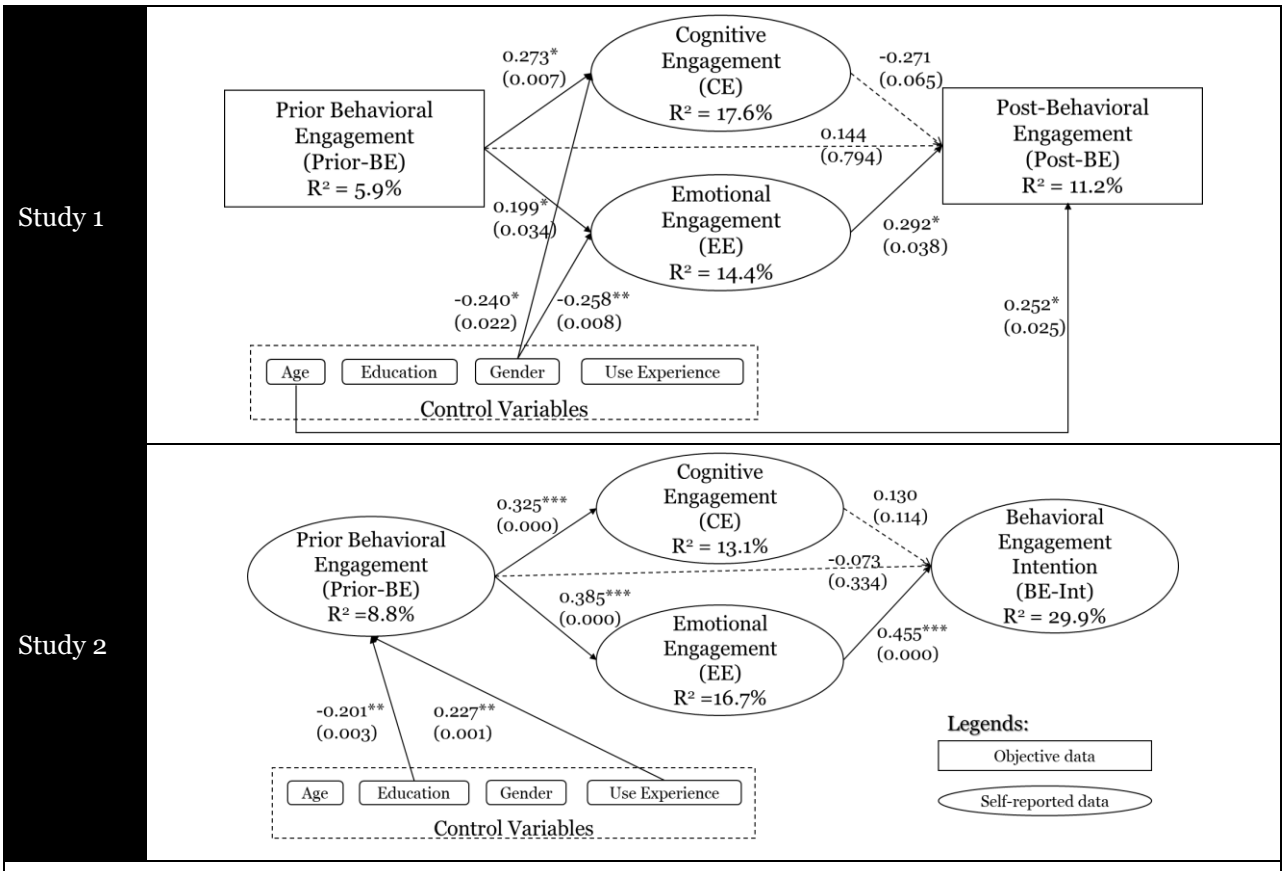

Table 6. Relationships among the Three Dimensions of User Engagement

Note: ***: p<0.001; **: p < 0.01; *: p < 0.05, two-tailed test. Standardized path coefficients are reported. Prior-BE in Study 2 is the same as BE in Tables 4 and 5.

Table 7. Results of Path Coefficient Comparison			
	Unstandardized Path Coefficients	Results	Conclusions
Study 1	$\beta_{CE\rightarrow Post\text{-}BE}$ vs.$\beta_{EE\rightarrow Post\text{-}BE}$ =-0.268 vs.0.284*	T=-7.673***	$\beta_{CE\rightarrow Post\text{-}BE} < \beta_{EE\rightarrow Post\text{-}BE}$
	$\beta_{BE\rightarrow Post\text{-}BE}$ vs.$\beta_{EE\rightarrow Post\text{-}BE}$ =0.028 vs.0.284*	T=-2.492*	$\beta_{BE\rightarrow Post\text{-}BE} < \beta_{EE\rightarrow Post\text{-}BE}$
Study 2	$\beta_{CE\rightarrow BE\text{-}Int}$ vs.$\beta_{EE\rightarrow BE\text{-}Int}$ = 0.133 vs.0.455***	T=-2.709**	$\beta_{CE\rightarrow BE\text{-}Int} < \beta_{EE\rightarrow BE\text{-}Int}$
	$\beta_{BE\rightarrow BE\text{-}Int}$ vs.$\beta_{EE\rightarrow BE\text{-}Int}$ = -0.054 vs.0.455***	T=-4.041***	$\beta_{BE\rightarrow BE\text{-}Int} < \beta_{EE\rightarrow BE\text{-}Int}$

Note: ***: p<0.001; **: p < 0.01; *: p < 0.05, two-tailed test.

Discussion

Expected Theoretical Contributions and Future Research Directions

Our study contributes to the theoretical development on technology use in the following aspects. First, we conceptualize a constructive form of technology use targeting ubiquitous mobile technologies that become popular in the recent decade. This new mobile technology generation is different from the early ones such as e-mail, World Wide Web, or early versions of Office tools (Adams et al.1992; Davis 1989; Jackson et al. 1997; Millman and Hartwick 1987), where the technology use construct stems from. This new technology generation is also different from complex information systems like enterprise resource planning systems (ERP) or customer relationship management systems (CRM) (Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005), where technology use is an integral part of task performances (Burton-Jones and Straub 2006; McGrath 1993). We identity the space for theoretical development and differentiates our conceptualization of mobile technology use with prior use concepts such as technology use behaviors in general (Bhattacherjee 2001; Davis et al. 1989) or creative use of organization-wide complex systems (Li et al. 2013; Sun 2012). We position user engagement or engaged use targeting ubiquitous mobile technologies such as mobile health or social network applications – these emerging tools expect users' active, constructive, and long-term involvement, which is not yet captured in prior IS literature.

Second, our conceptualization of user engagement with mobile technologies contains three dimensions characterizing physical, cognitive, and emotional aspects of technology use. Most of the usage forms in prior IS literature are with solo dimension. Scholars were usually interested in and called for attention to a particular aspect of technology use, e.g., emotion (Beaudry and Pinsonneault 2010; Guinea and Markus 2009; Zhang 2013), cognition (Agarwal and Karahanna 2000; Polites and Karahanna 2012), and behavior in general (Davis et al.1989; Venkatesh et al. 2003). The scholars treated the cognitive or emotional aspects of use as predictors of behavioral use, rather than including them as different dimensions within the same technology use construct. We are among the first to synthesize the prior literature and propose a form of effective technology use that is boarder in conceptual boundary. We also significantly extend the preliminary works on user engagement in the IS field (Webster and Ahuja 2006; Ray et al. 2014), in terms of construct conceptualization and operationalization. We validated the measures of user engagement across to two different mobile technology contexts, and further explored the structural relationships among the three engagement dimensions.

Third, across two empirical studies, we found that prior behavioral engagement contributed to both cognitive and emotional engagement, whereas emotional engagement displayed a stronger influence on post behavioral engagement than both prior behavioral engagement and cognitive engagement did. Most of the studies on technology use examine how cognition and emotion contributes to behavior, rather than how behavior affects cognition and emotion during usage processes. Moreover, technology use literature has long been dominated by cognition-based models (e.g., Davis et al. 1989; Venkatesh et al. 2012), and emotion has received limited attention so far (except Beaudry and Pinsonneault 2010; Guinea and Markus 2009; Zhang 2013). Our findings echoed the handful studies focusing on the emotion aspect of technology use, and retained that in the ubiquitous mobile technology context, emotional engagement outweighed behavioral or cognitive engagement in predicting future behavioral engagement. In addition, our findings also provide contextualized interpretations on the structural relationships among the three

engagement dimensions and excel beyond the extant knowledge on the engagement concept from other disciplines as we have reviewed in Table 1.

As this paper only presents preliminary findings of our research project, we list out the limitations together with future research directions. First, we did not validate user engagement in a more comprehensive nomological network. Due to the time and space constraints, we did not examine discriminant validity between user engagement and the set of relevant constructs discussed in Table 2. Second, we tested the measures only in two different mobile technology context and most of the users were in Asia. This limits the generalizability of our measures. The next steps of our research project include: 1) to validate the measures of user engagement in different mobile technology and cultural contexts, 2) to examine how different experimental conditions can stimulate the three dimensions of user engagement, and 3) to investigate how the three dimensions differentially produce outcomes in different mobile technological settings, e.g., consumer satisfaction, task performances, health conditions, and learning effectiveness.

Expected Practical Contributions

Our findings also provide comprehensive practical insights on how to engage users of mobile technologies through different aspects of behavior, cognition, and emotion. First, for data scientists, we recommend them collect subjective data capturing the cognitive and emotional aspects of users, understand their usage behaviors, and further leverage embedded business and social value through integration of subjective and objective data. Second, for managers who want to penetrate markets for mobile applications, we suggest them improve interface design of mobile applications and pay particular attention to the emotional aspect, e.g., text font and color, accompanying pictures and music, and interactive animations. Third, for e-commerce sites, we advise managers add social elements, e.g., social network activities between sellers and buyers, or buyers' peer-to-peer advice seeking and giving, which is the easiest way to engage consumers. In addition to the business context, practitioners in the education and healthcare contexts can generate similar insights from our findings. For example, e-learning applications can add social elements and engage students through stimulating their affective responses. Fitness and sports mobile applications could assess users' cognitive and emotional states through short surveys and integrate them with usage archives in analyzing the big data.

Conclusion

We appropriated insights on the engagement concept from organizational behavior, consumer psychology, education psychology, and healthcare, and conceptualized user engagement as entailing behavioral, cognitive, and emotional dimensions in using ubiquitous mobile technologies. We also distinguished user engagement from a series of relevant constructs in the IS field, including involvement, flow, intrinsic motivation, and addiction. Across two different mobile technology contexts, we validated the measures of the three engagement dimensions and found that behavioral engagement led to emotional and cognitive engagement, while emotional engagement displayed the strongest predictive power on behavioral engagement among the three engagement dimensions. Our study enriches the technology use literature and advances the understanding on the engagement concept as well as the relationships among its three dimensions in the IS field, at the same time, offer practitioners with suggestions on how to constructively engage users of mobile technologies.

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Appendix A

Construct	Sources	Measures
Behavioral Engagement (BE)	Claussen et al. 2013	*Objective (from data archives)* Frequency: average daily use – total number of times Duration: average daily use – total duration
		Subjective (in survey) Frequency: In the past few weeks, the average number of times you use XXX per day 1. Less than twice, 2. Three to five times, 3. Six to ten times, 4. More than ten times Duration: In the past few weeks, the average total duration of using XXX per day 1. Less than half an hour, 2. A half to one hour, 3. One to two hours, 4. More than two hours
Behavioral Engagement Intention (BE-Int)	Bhattacherjee 2001, 2004; Claussen et al. 2013; Thomson et al. 2005	BE-Int1. I intend to use XXX frequently in the next few weeks. BE-Int2. I intend to spend much time using XXX in the next few weeks.
Cognitive Engagement (CE)	Rothbard 2001	Absorption1. I am completely engrossed in using XXX. Absorption2. I am totally absorbed in using XXX. Attention1. I focus a great deal of attention when using XXX. Attention2. I concentrate a lot when using XXX. Attention3. I pay a lot of attention when using XXX.
Emotional Engagement (EE)	Thomson et al. 2005	Affection1. I feel affectionate toward XXX. Affection2. I feel friendly toward XXX. Affection3. I feel loved in using XXX. Connection1. I am bonded with XXX when using it. Connection2. I feel attached to XXX when using it. Connection3. I am connected with XXX when using it.